

**5.—CONTRIBUTIONS TO THE MINERALOGY OF WESTERN  
AUSTRALIA.**

*Series iii.*

(With two figures, 1 and 2.)

*By*

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**(1.) TANTEUXENITE (Sp. nov.), PILBARA GOLDFIELD, N.W. DIV.**

Two minerals resembling euxenite in appearance have been observed on several of the tinfields of the Pilbara goldfield. One of these has now been sufficiently investigated to show that it is a new mineral species, and to enable a systematic physical and chemical description of it to be given.

Whilst normal euxenite—which has been described from Norway, Sweden, Greenland, Ontario, Brazil, Transvaal, and Madagascar—is a titanoniobate of yttrium, the mineral here described differs from it in being essentially a titanotantalate of yttrium. This substitution of tantalum for niobium is evidenced in the higher specific gravity, that for euxenite being 4.6 to 5.1, whilst for the Pilbara minerals it is 5.4 to 5.9. A new name being required for the species, Tanteuxenite is suggested. The derivation of the name is obvious.

Tanteuxenite was first detected at *Cooglegong* in some angular boulders shed from a pegmatite vein. In these it was found in masses up to 200 grammes in weight associated with grey quartz. It exhibited traces of a flattened prismatic structure, and on a fresh fracture, which was conchoidal to subconchoidal, had a brownish black colour with brilliant resinous lustre. Most of the surface, and some approximately parallel fractures, were coated with a very thin film of grey decomposition products.

In mass the Coolegong mineral is opaque and nearly black in colour, but thin splinters are translucent up to a thickness of 0.5 mm., and transmit a pale to dark amber light according to thickness. The fine powder is of a tawny olive (17°i) colour, and under the microscope is transparent and isotropic, with an amber colour. When a fragment is heated in a closed tube it decrepitates slightly, gives off water and becomes much paler in colour, approximating that of the powdered mineral.

An analysis is given in column (1) below. A second similar specimen had a specific gravity of 5.64 with 16.1 per cent. of  $\text{TiO}_2$ . It was found to be easily broken up by fusion with potassium carbonate or potassium hydroxide, or by heating with a mixture of HF and  $\text{H}_2\text{SO}_4$ .

The mineral here described must not be confused with that from the same locality referred to by the writer as euxenite in the "Transactions of the Australasian Association" for 1907 (Vol. XI., p. 446). This mineral, which is the second one referred to in the first paragraph above, apparently occurs also at Leeds tin find on Abydos Station. It is somewhat different in appearance, and contains much more titanium oxide than tanteuxenite, and is being further investigated. It is probably the tantalum mineral corresponding to polycrase or blomstrandine, according to the latest convention.

From a pegmatite in granite a few miles S.E. of Cunmagnunna Trig. (B4) on *Woodstock Station*, a few pounds of less typical tanteuxenite have been obtained. During a brief inspection the writer could find no more beyond the small pocket originally discovered in 1926. The mineral from this place is similar in appearance to that from Cooglegong. It has a hardness of 5.5 to 6.0, is devoid of crystalline form or cleavage, has a sub-conchoidal fracture, is brownish black in colour, and opaque in mass, with a resinous lustre. The powder is tawny olive in colour, and under the microscope transparent, brownish-amber, and isotropic.

Titanium determinations on various fragments gave from 20 to 21 per cent. of  $\text{TiO}_2$ , the specific gravity ranging from 5.5 to 5.6. Two complete analyses were made, and are given in columns (2) and (3) below. The mean figures indicate a much smaller excess of tantalum over niobium than is the case with the Cooglegong mineral. The definite detection of bismuth in the mineral is of interest, as it has never previously been observed in a mineral of this type. Failure to recognise it and separate it from the associated lead in such minerals would vitiate any calculation regarding their age. The geological age calculated from the Woodstock mineral is excessive, and it is evident that either lead has been added to the mineral, or uranium leached out by weathering, or, like the plumboniobite of East Africa, it contains primary lead.

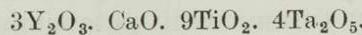
## Tanteuxenite, Cooglegong and Woodstock.

		Cooglegong.	Woodstock, A.	Woodstock, B.
Ta <sub>2</sub> O <sub>5</sub>	...	47.31	22.95	24.84
Nb <sub>2</sub> O <sub>5</sub>	...	3.83	15.27	13.40
TiO <sub>2</sub>	...	14.17	21.05	20.71
SnO <sub>2</sub>	...	.14	.44	.42
ThO <sub>2</sub>	...	trace	2.86	3.16
Y <sub>2</sub> O <sub>3</sub> , Er <sub>2</sub> O <sub>3</sub>	...	17.48	16.36*	16.62†
Ce <sub>2</sub> O <sub>3</sub>	...	} 7.22 {	9.40	9.04
La <sub>2</sub> O <sub>3</sub> .Di <sub>2</sub> O <sub>3</sub>	...		.14	.34
UO <sub>3</sub>	...	3.35	4.16	4.04
PbO	...	traces	1.71	1.64
Fe <sub>2</sub> O <sub>3</sub>	...	1.18	1.53	1.48
MnO	...	.35	.28	.28
CaO	...	2.22	.97	.97
Al <sub>2</sub> O <sub>3</sub>	...	Nil	.31	.61
Bi <sub>2</sub> O <sub>3</sub>	...	Nil	.04	.04
SiO <sub>2</sub>	...	.90	.13	.56
Na <sub>2</sub> O	...	trace	Nil	Nil
Ign.	...	2.40	2.24	2.16
Total	...	100.55	99.84	100.31
Sp. Gr.	...	5.77	5.55	5.55
Analyst	...	E.S.S.	D. G. Murray	D.G.M.

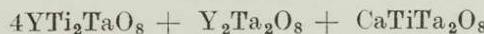
\* Approx. Y<sub>2</sub>O<sub>3</sub>, 11.32; Er<sub>2</sub>O<sub>3</sub>, 5.04.

† Approx. Y<sub>2</sub>O<sub>3</sub>, 11.50; Er<sub>2</sub>O<sub>3</sub>, 5.12.

Assuming that the UO<sub>3</sub> represents weathered UO<sub>2</sub>, and that this and the ThO<sub>2</sub> are isomorphous with the TiO<sub>2</sub>, the mean figures for the two Woodstock analyses give approximately the formula—



which is equivalent to an isomorphous eocrystallisation of—



from which the essential constituent of tanteuxenite is considered to be YTi<sub>2</sub>TaO<sub>8</sub>; and of euxenite, YTi<sub>2</sub>NbO<sub>8</sub>. Expanded, these formulae are of the form Y<sub>2</sub>O<sub>3</sub>.4TiO<sub>2</sub>.Ta<sub>2</sub>O<sub>5</sub>.

Two other localities in the North-West division have yielded specimens of a mineral not yet analysed, but assumed to be tanteuxenite on account of their chemical and physical properties. They are Eleys, 10 miles S. of Cooglegong, and 40 miles E.N.E. of the Woodstock find, and Mt. Francisco, 30 miles N.W. of Woodstock.

At Eleys the mineral is plentiful in alluvial tin rejects from Mineral Claim 15, forming 27 per cent. of a parcel of rejects collected by the writer in 1927. It is in subangular to well rounded pebbles, ranging in weight from 0.5 to 4 grammes. On the exposed surface it is brown or brownish black in colour with dull lustre, but fresh fractures reveal the typical resinous lustre and normal appearance both in mass and under the microscope. A series of specific gravities determined were 5.61, 5.58, 5.56, 5.54, 5.50, 5.36. The pebble with a gravity of 5.58 had 18.07 per cent. of TiO<sub>2</sub>.

Several specimens from Eleys are distinctly tabular in structure, and almost certainly orthorhombic, though they are too water-worn to be capable of angular measurement. The commonest forms appear to be (100), (010) and (001). What appear to be the prism faces are vertically striated.

On a tin lease six miles S.E. of the Government well at *Mt. Francisco*, the writer found water-worn pebbles of tanteuxenite not uncommon in alluvial tin concentrates. The pebbles collected never had a greater mass than 2 grammes, and were coated with a strongly adherent reddish brown decomposition product with a dull lustre. After removing part of this coating by dipping in and out of hydrofluoric acid, specific gravities of 5.42, 5.59, 5.71, 5.78, and 5.90 were obtained. The pebble with a gravity of 5.78 contained 18.16 per cent. of  $TiO_2$ . On a fresh fracture the mineral had the typical appearance of tanteuxenite and indistinct indications of tabular crystallisation were again apparent.

A systematic description of the mineral is as follows:—*Tanteuxenite*: Essential composition, a titanotantalate of yttrium,  $YTi_2TaO_s$ ; ( $Y_2O_3 \cdot 4TiO_2 \cdot Ta_2O_5$ ), a minor part of the tantalum being replaceable by niobium. Other isomorphous replacements of the whole molecule are probably  $CaTiTa_2O_s$  and  $Y_2Ta_2O_s$ , whilst Th and U may partly replace Ti, and Er, Ce, etc., partly replace Y. Orthorhombic; habit tabular parallel to the macropinacoid. Cleavage, none; fracture, conchoidal to subconchoidal. Hardness, 5 to 6; brittle. G, 5.4 to 5.9, the variation mainly due to varying proportions of tantalum and niobium. Colour in mass brownish black to dark brown (seal brown, 5"m); apparently opaque, but translucent at about 0.5mm. Powder greyish yellow (typically tawny olive, 17"i), transparent and brownish yellow under the microscope, and abnormally isotropic owing to hydration. Before the blowpipe, infusible, glows not at all or only very slightly, sometimes decrepitates, always yields water, and coarse fragments pale to about the colour of the powdered mineral. Slowly attacked by hot strong hydrochloric or sulphuric acid, but most readily dissolved by a mixture of hydrofluoric and sulphuric acids, or by fusion with potassium carbonate or potassium hydroxide and treatment of the fused mass with hydrochloric acid. The type mineral is that from Cooglegong.

## (2) MICROLITE, STRELLEY, N.W. DIV.

The first record of microlite in Australia was that made by the writer in 1907 of this mineral at Green's Well near Wodgina\*. In 1917 the writer described tapiolite from Strelley, then known as Tabba Tabba North. The latter deposit is now being reworked and in parcels of ore from  $2\frac{1}{2}$  miles north of M.L. 321, there has been detected an occasional intergrowth of tapiolite and microlite.

The mixture is in coarse detrital pebbles weighing up to 100 grammes. In one case only were any crystal faces observed and these appeared to indicate that the whole mass had the form of a complex twin of tapiolite. The other pebbles are well water worn. The major part of each pebble consists of a black iron tantalate, apparently tapiolite. Irregular portions of the surface are composed, however, of a second opaque mineral of a pale buff to

\* A.A.A.S. 1907, p. 451, also A.A.A.S. 1909, p. 314.

cinnamon colour, and on fracturing the specimens, these areas are found to penetrate to varying depths, forming ragged boundaries with the tapiolite and often penetrating deeply into it in minute veins. This structure, in conjunction with the one crystal observed, suggests that the pale mineral is a replacement of the tapiolite.

For detailed examination a pebble weighing 85 grammes and having a density of 6.51 was chosen. It was split into four pieces having densities of 6.85, 6.50, 6.50, and 6.20. The lightest piece showed the greatest proportion of the pale coloured mineral. It was crushed and analysed with the following results:—

*Intergrowth of Microlite and Tapiolite, Strelley.*

Ta <sub>2</sub> O <sub>5</sub>	Nb <sub>2</sub> O <sub>5</sub>	TiO <sub>2</sub>	SnO <sub>2</sub>	SiO <sub>2</sub>	CaO	MgO	MnO	FeO	Fe <sub>2</sub> O <sub>3</sub>
77.96	.96	.30	.40	1.76	7.12	Nil	.60	2.88	1.78
Al <sub>2</sub> O <sub>3</sub>	Na <sub>2</sub> O	K <sub>2</sub> O	F	H <sub>2</sub> O+	H <sub>2</sub> O-	Total	Less O = F		
.24	3.68	.15	2.04	.40	.09	100.36	0.68		

For the careful analysis made the writer is indebted to Mr. D. G. Murray of the Government Laboratory.

The analysis confirms the light coloured mineral as being a fluotantalate of lime and soda, without doubt microlite. Examination of the analysed powder under the microscope indicated a relative volume of three parts of black opaque tapiolite to 10 parts of transparent, almost colourless, isotropic, microlite. Associated with them were a few small grains of quartz, albite and limonite.

Microlite is usually described as being a pyro-tantalate with two molecules of lime to one of tantalic oxide, a commonly accepted formula being 3Ca<sub>2</sub>Ta<sub>2</sub>O<sub>7</sub>.NaF. The most satisfactory analysis of the mineral hitherto published, that of the Virginian mineral, does not however bear this out, but indicates rather a metatantalate, corresponding approximately to CaTa<sub>2</sub>O<sub>6</sub>.NaF or 3CaTa<sub>2</sub>O<sub>6</sub>.2NaF.

The analysis of the Strelley mixture gives a ratio for all protoxides to all tantalic and niobic oxides of one to one. Since the tapiolite portion of the mixture is known to have this ratio it follows that the residue must have the same ratio, that is, that the Strelley microlite is a metatantalate. Assuming the formula CaTa<sub>2</sub>O<sub>6</sub>.NaF for it, the analysis agrees almost exactly with the following mineral composition:—

					per cent.
Microlite	...	...	...	...	68.8
Tapiolite	...	...	...	...	27.3
Limonite	...	...	...	...	1.6
Albite	...	...	...	...	1.1
Quartz	...	...	...	...	1.0
Water	...	...	...	...	.2
					100.0

Such a mixture would have by calculation a density of 6.1 against the observed density of 6.2. It would also have a volume ratio of tapiolite to microlite of 10 to 3, a ratio confirmed by several counts under the microscope of the analysed powder.

## (3) ANDALUSITE, TOODYAY, S.W. DIV.

We are indebted to Mr. J. E. Wells, a member of this Society, for several important discoveries in the Toodyay district, the latest of which is that of andalusite at two points in Jimperding Valley, about six miles S.W. of the Toodyay railway station. Both places are in a belt of mica schists running approximately N.W. through the valley.

The first find was on a cultivated field, about one mile S.S.W. of Kowal-you-Katta Hill. Whilst the mica schists were half a mile wide, the andalusite was confined to some low hills occupying a few acres only, lying between, and possibly genetically connected with, two parallel epidiorite dykes. Loose crystals of andalusite were lying in profusion over the soil, and the rock outcrops were thickly studded with them. It was not unusual to find between five and ten per cent. of the exposed area of the schist consisting of projecting crystals. The crystals vary in size from  $10 \times 5 \times 5$  to  $40 \times 40 \times 40$  or  $60 \times 20 \times 20$  millimetres. Their form is that of a fairly sharply outlined prism (110) with imperfectly defined terminations. The ends taper off indefinitely, or are terminated at each end by single faces approximating to (011) and (0-1-1). Rarely the termination is roughly at right angles to the prism. The crystals weather out, or break out, of the schist with very little adherent mica.

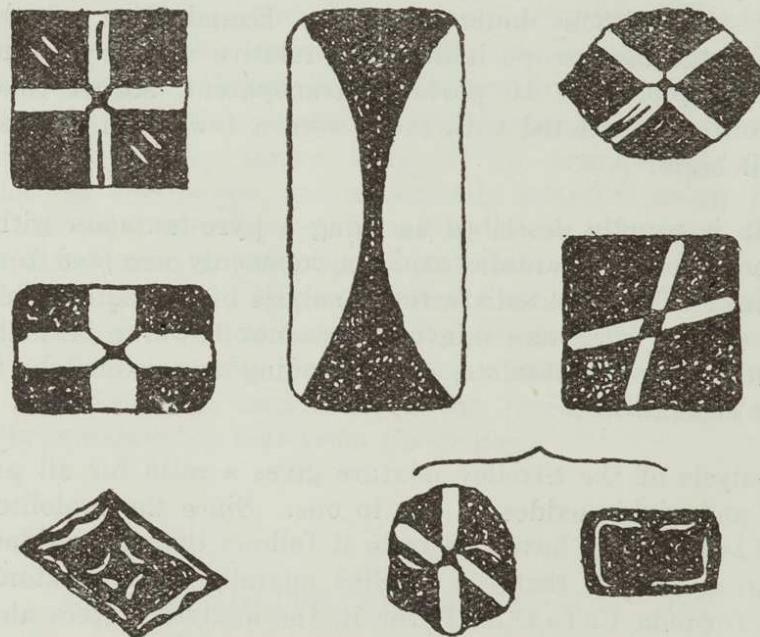


Fig. 1.—Chiastolite Crystals, Toodyay. Scale: natural.

The bracketed cross-sections represent opposite ends of one crystal. The vertical section indicates a black centred cross at the middle with a hollow white square at either end.

In this occurrence the crystals are dark grey in colour owing to inclusion of carbon dust, and many of the larger ones exhibit typical chiastolitic structure when cross sectioned. One such exhibited a hollow white square at one end, passing into a central cross at the other, like the crystal figured by Dana in his System.\* Many others show white cruciform figures, often with black centres at the intersections, whose limbs make angles ranging from  $60^\circ$  to  $90^\circ$  with one another. Two crystals split parallel to (110) showed an hour-glass arrangement of the carbonaceous inclusions. (See Fig. 1.)

\* System of Mineralogy, VII., 497.

About  $1\frac{1}{2}$  miles to the S.S.E., on the same belt of schist, a second andalusite bearing zone has been discovered. The crystals here are of similar size and approximately similar form to those at the first place. They are, however, much less heavily charged with carbon, and so far as yet observed, have not any geometrical arrangement of the inclusions. A distinct feature of this occurrence is the invariable outer coat of mica 2 to 5 mm. thick on each crystal. This mica is in fairly coarse plates arranged at right angles to the adjacent andalusite face, and the coating preserves externally, in a roughened form the shape of the enclosed crystal. The junction between the mica and the andalusite is at times a sharply defined face of the latter, at times quite ragged. This mica, in its orientation relative to the andalusite crystals, is quite distinct from that of the schist, and adheres persistently to the crystals which weather out from the rock. It is plainly an alteration product of the andalusite such as has been recorded in several localities by Hintze and Lacroix.

#### (4) GROSSULARITE, MT. FRANCISO, N.W. DIV.

Up till recently 76 mineral species had been detected within a 20-mile radius of Mt. Tinstone in the Wodgina massif. Grossularite, which has now been found close to the Government Well at Mt. Francisco, brings the total of species up to 77.

The mineral is in large uncryallised masses with small inclusions of epidote. Its matrix is unknown. The garnet in colour ranges from about Ridgway's 11'b (onion skin pink) to 9'k (walnut brown), the paler tints prevailing. It is translucent in a thickness of 2mm. An analysis of a typical light-coloured fragment gave:—

$\text{SiO}_2$	$\text{Al}_2\text{O}_3$	$\text{Fe}_2\text{O}_3$	$\text{FeO}$	$\text{MnO}$	$\text{MgO}$	$\text{CaO}$	$\text{H}_2\text{O}+$	Total.
38.50	18.94	4.90	1.52	.23	.49	35.08	.32	99.98

The specific gravity is 3.65.

The percentage proportions of the pure isomorphous molecules calculated from the analysis are:—

Grossularite	...	...	...	81.0
Andradite	...	...	...	13.7
Almandine	...	...	...	3.2
Pyrope	...	...	...	1.9
Spessartite	...	...	...	.2
				100.0

#### (5) SPESSARTITE, TABBA AND STANNUM, N.W. DIV.

Detrital tantalite concentrates obtained by the writer from the surface soil of Thelemann's M.L. 317, at Tabba, contained a large number of small (2 to 3 mm.) loose crystals of spessartite. They all have the same form, viz., the trapezohedron (211) with more or less distinct traces of the dodecahedron (110). In colour they range from Ridgways 13'' (orange cinnamon) to 13''d (light vinaceous cinnamon). They are translucent in a thickness of about 2 mm., and isotropic.

An analysis given in column (1) below shows the mineral is a fairly typical spessartite, with 85 per cent. of pure spessartite molecules and 15

per cent. of almandine. In view of Dana's description of the colour of spessartite, viz., "dark hyacinth red, sometimes with a tinge of violet, to brownish red," the pale colour of this, and the previously described Wodgina spessartite,\* is noteworthy. It is to be observed, however, that Hintze (H-B der Min. II., 67) says of spessartite that "the purest varieties have a yellow colour"; and Lacroix (Min. de Fr. I., 255) says "colour, light yellowish brown, brownish red more or less dark." The mineral is doubtless derived from one of the adjacent tantalite-bearing pegmatites.

A garnet collected near the old tin workings at Stannum is very different in appearance. The detrital specimens received are distinctly crystallised in trapezohedra (211) reaching to 5 cm. in diameter, the larger ones often enclosing much quartz towards the centre. The colour in mass varies from 77<sup>k</sup> (cameo brown) to almost black, the lighter ones being translucent in thicknesses of about 1mm., and isotropic.

An analysis was made of one of the darker specimens with the results given below in column (2). The molecular ratios do not agree closely with those established for garnet unless we assume that all the iron was originally in the ferrous condition, weathering having oxidised some of it to ferric oxide. On this quite justifiable assumption the molecular composition of the garnet, in terms of the pure molecules is spessartite, 50.5; almandine, 49.1; pyrope, 0.2; grossularite, 0.2. A second specimen had a specific gravity of 4.21 with 12.8 per cent. of ferrous oxide, indicating a smaller proportion of the almandine molecule.

		Tabba.	Stannum.
SiO <sub>2</sub>	...	36.79	35.77
Al <sub>2</sub> O <sub>3</sub>	...	20.40	20.38
Fe <sub>2</sub> O <sub>3</sub>	...	.46	3.00
FeO	...	6.71	18.83
MnO	...	35.87	21.84
MgO	...	<i>Nil</i>	.06
CaO	...	<i>Nil</i>	.06
H <sub>2</sub> O+	...	.16	.16
Total	...	100.43	100.18
Sp. Gr.	...	4.18	4.24
Analyst	...	J. N. A. Grace.	C. R. Le Mesurier

#### (6.) ANDRADITE, MELVILLE AND WEELHAMBY LAKE.

Large masses of garnet occur in the Archaean greenstone forming the walls of a gold bearing vein on Harrison's Lease No. 27, at Melville (Murdochison Division). These masses are intergrowths of a number of individual crystals which by mutual interference have only been allowed to develop a few imperfect trapezohedral faces. The mineral is dark brown in colour (about Ridgway 8 m.) and is only translucent in thin splinters, about 0.5 mm. Some small inclusions of quartz can be seen in the masses.

\* J.R.S.W.A., XIII. (1927), 41.

An analysis was made of some of the cleanest mineral with the results given below. They indicate the presence of about 5.28 per cent. of included quartz; after deducting this the ratios  $\text{RO} : \text{R}_2\text{O}_3 : \text{SiO}_2$  become 2.995: 1.001: 2.997. The remaining garnet is a typical andradite with the following proportions of the pure molecules:

Andradite	...	...	95.4
Fe'' Fe''' garnet	...	...	3.4
Almandine	...	...	.7
Spessartite	...	...	.5
			—
			100.0
			—

Specimens of andradite in masses up to a kilogramme in weight have been collected on the surface at Weelhamby Lake, 15 miles N.E. of Bowgada (S.W. Division). They are devoid of crystal faces and less vitreous and darker in colour than the Melville mineral, being about Ridgway's 11" m. Even the cleanest mineral selected for analysis was contaminated with a few minute grains of epidote, actinolite and quartz. The results of analysing this slightly impure mineral are given in column (3) below, from which the calculated ratios  $\text{RO} : \text{R}_2\text{O}_3 : \text{SiO}_2$  are 3.00: 0.95: 3.17. The calculated molecular percentages show a large cocrystallisation of the grossularite molecule, the figures being:—

Andradite	...	...	57
Grossularite	...	...	34
Almandine	...	...	4
Spessartite	...	...	4
Pyrope	...	...	1
			—
			100
			—

The analytical figures are:—

—	(1.)	(2.)	(3.)
$\text{SiO}_2$	38.79	35.37	38.40
$\text{TiO}_2$	.01	.01	.41
$\text{Al}_2\text{O}_3$	.22	.23	8.27
$\text{Fe}_2\text{O}_3$	29.38	31.01	17.90
FeO	1.61	1.70	1.76
MnO	.20	.21	1.38
MgO	.01	.01	.29
CaO	29.85	31.51	31.21
$\text{H}_2\text{O}$	.13	.14	.32
	100.20	100.19	99.94
G.	3.87	3.97	3.59
Analyst, C. R. LeMesurier.			

(1.) Andradite contaminated with quartz, Melville.

(2.) The same calculated after deducting 5.28 per cent. quartz.

(3.) Andradite slightly contaminated with epidote, quartz, and actinolite, Weelhamby Lake.

## (7.) SPODUMENE, WODGINA, N.W. DIV.

In the spring of 1927 the writer found spodumene to be plentiful in boulders of pegmatite on one of the dumps of the Mt. Cassiterite Tin Mine. The mineral is in flat cleavable masses from 5 x 3 x 2 mm. up to 50 x 25 x 5 mm. The only faces seen are a(100), b(010), and m(110); the terminations of the prisms are indefinite. The colour in mass is "pallid neutral grey" or "pale olive grey" to "olive buff." An analysis by Mr. H. P. Rowledge gave the following figures:—

$\text{SiO}_2$	$\text{Al}_2\text{O}_3$	$\text{Fe}_2\text{O}_3$	$\text{FeO}$	$\text{MnO}$	$\text{MgO}$	$\text{CaO}$
64.17	28.08	.12	.21	.18	.11	<i>Nil</i>
$\text{Li}_2\text{O}$	$\text{Na}_2\text{O}$	$\text{K}_2\text{O}$	$\text{TiO}_2$	$\text{H}_2\text{O}+$	Total	G.
6.70	.37	.22	.03	.30	100.49	3.17

## (8.) CUMMINGTONITE, WARRIEDAR, S.W. DIV.

In his Bulletin dealing with the gold mines at Warriedar\* F. R. Feldtmann refers in several places to the occurrence of "asbestos" in the mines. This mineral was a source of difficulty in the batteries, where it caused from time to time a clogging of the screens.

In 1923 the writer collected specimens of this mineral at the Mug's Luck gold mine, where it was found to fill discontinuous veins and form confused masses in a slightly shattered, microscopically fibrous amphibolite. The fibres range from 2 to 10 mm. in length, are very fine in staple, and somewhat brittle. The least altered mineral is "mineral grey" (Ridgway 25'''d) in colour, but the ferrous iron in it is prone to oxidise, and the collected specimens, which came from ground-water level, exhibit all stages of alteration with corresponding ranges of colour from grey to "cinnamon" (15').

Some of the grey, apparently unaltered, mineral with a specific gravity of 3.28 was selected for analysis and gave the following results:—

$\text{SiO}_2$	$\text{Al}_2\text{O}_3$	$\text{Fe}_2\text{O}_3$	$\text{FeO}$	$\text{MnO}$	$\text{MgO}$	$\text{CaO}$
56.74	.91	3.14	24.41	1.58	9.72	.42
$\text{Na}_2\text{O}$	$\text{K}_2\text{O}$	$\text{H}_2\text{O}+$	$\text{H}_2\text{O}-$	Total		
<i>Nil</i>	<i>Nil</i>	3.03	.78	100.73		

Analyst: H. P. Rowledge.

The analysis indicates a ferro-anthophyllite or cummingtonite.

Examination of the fibres under the microscope reveals the fact that whilst the majority of them give a straight extinction, some exhibit an extinction angle up to 15deg. This suggests that the mineral is the monoclinic cummingtonite (recorded extinction angle, 17deg.), rather than the orthorhombic anthophyllite. Both minerals belong to the amphibole group and have at times an asbestosiform structure.

This is the first record of cummingtonite in the State.

## (9) CORUNDUM, ABYDOS, BURBANKS AND BALBARRUP.

Five miles north of the homestead on Abydos Station (N.W. Div.) in gently undulating granite country traversed by numerous pegmatite veins, there is a band of chlorite-biotite schist about 8 feet wide, which carries corundum. This rock can be traced for several chains through the granite and passes into a hornblende felspar gneiss. Several pounds of detrital and

usually fractured crystals, were picked up in a short time by the writer and a few specimens were seen embedded in the schist, from which subsequently about 3 cwt. of mineral was obtained in digging to a depth of 6 feet.

The crystals vary in size from 3 x 1 cm. to broken fragments having a diameter of 5 cm. They are distinctly, and sometimes sharply, hexagonal in basal section, and taper roughly towards each end, the actual pyramids present, in addition to the unit prism, being indeterminate. An imperfect basal parting is present, which discloses a multiple zoning clearly and sharply defined in concentric hexagons of slightly varying shades of the main colours, the powder from a single crystal varying from pale blue to lilac. In mass the colours of different crystals range from Ridgways 57'm (dusky blue violet) through 59" (hyssop violet) to 65"b (argyle purple). A narrow dull green (37'i) outermost zone is noticed on some crystals. The surface is coated with strongly adherent mica. The twinning plane r (10-11) is strongly marked, with striations of  $r^2$  and  $r^3$  plainly visible. The measured angle  $r^1 r^2$  was  $94^\circ$ . A density of 3.94 was noted.

About two miles west of the townsite of Burbanks (Cen. Div.) is an outcrop of brilliant green fuchsite schist in which strings and globular aggregates of a finely granular red mineral can be seen. By crushing and panning the rock this mineral can be collected in the form of a heavy concentrate which is Indian lake (71'i) in colour when wet, but slightly paler when dry, viz., about magenta (67').

Under the microscope the mineral is seen to be corundum crystallised in hexagonal bipyramids and prisms, the common forms being z (22-41), c (0001) and a (11-20) in the combinations ze, aze or ac. A basal cleavage is seen in most of the crystals and a rhombohedral parting in several. The largest crystal is 1 mm. long and 0.2 mm. in diameter. The density is 4.01. All are transparent and strongly pleochroic, O being hyssop violet (Ridgway 59") and E, very pale yellow.

The colour and transparency of the Burbanks mineral bring it within the definition of ruby, but so far no crystal has been discovered large enough to be cut into a gem.

Besides fuchsite the accompanying minerals are brown andalusite, which is plentiful, and small crystals of blue kyanite, which are rare.

A gravelly alluvial concentrate from Balbarrup (S.W. Div.) on examination proved to be a mixture of rutile, kyanite and dull yellowish corundum. The latter was in rounded, often corroded, pebbles from 2 to 5 mm. in diameter exhibiting occasionally a rhombohedral parting. The corroded fragments had some white clay adherent to them. The composition of some of the cleanest fragments was:—

$\text{Al}_2\text{O}_3$	$\text{Fe}_2\text{O}_3$	$\text{MgO}$	$\text{SiO}_2$	$\text{TiO}_2$	$\text{H}_2\text{O}$	Total	G.
83.84	3.70	trace	9.04	1.98	1.44	100.00	3.88

No.  $\text{CaO}$ ,  $\text{ZrO}_2$ , rare earths,  $\text{P}_2\text{O}_5$ , or  $\text{Ta}_2\text{O}_5$  could be detected in it.

In mass the mineral is opaque with dull to waxy, or very rarely brilliant, lustre. Under the microscope the powder is colourless with films of yellow limonite; and many rhombohedral parting plates are seen with angles of  $93^\circ$  and  $87^\circ$ , diagonal extinction, and low birefringence.

## (10.) OCTAHEDRITE, KUNJIN, S.W. DIV.

When making a mechanical analysis of a pure white, very fine grained pottery clay, probably a kaolinised epidiorite, from Kunjin, a small percentage (0.05 per cent.) of heavy concentrate was obtained. The constituents of this all had densities over 3.3 (methylene iodide), the most abundant of them being zircon.

About one-fifth of the concentrate was typical octahedrite in flat crystals, probably cleavage plates, parallel to (001). The outlines of some typical individuals, drawn to scale, are shown in the accompanying figure (Fig. 2). The combination most commonly observed was  $c^1e_1$

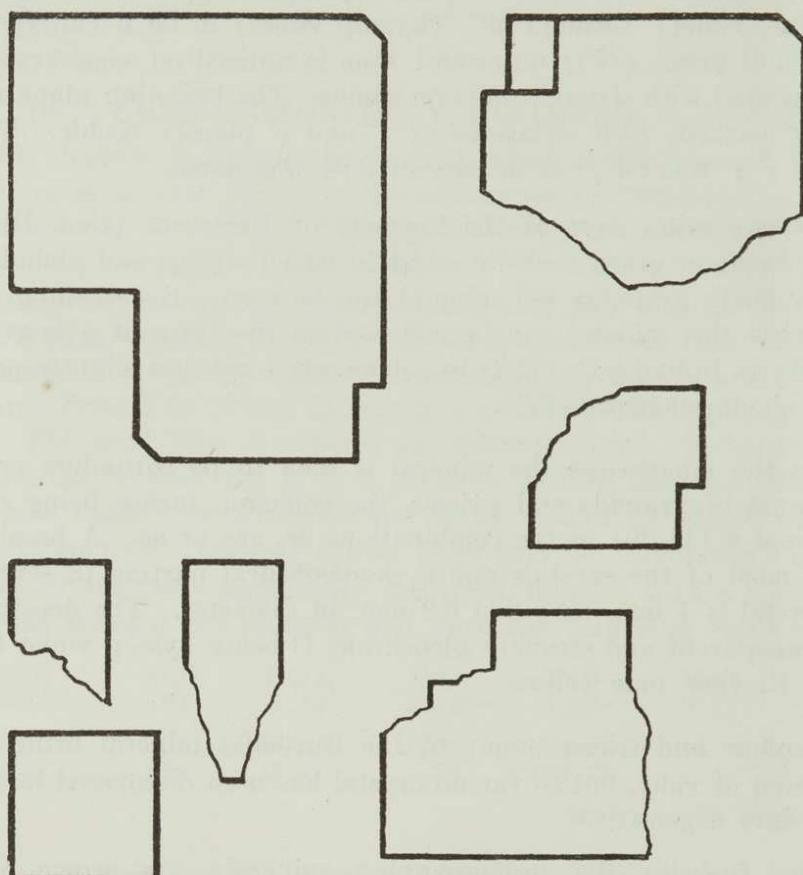


Fig. 2.—Octahedrite, Kunjin. Scale : 1 : 200.

$p^1 p^2 p^3 p^4 p_1 p_2 p_3 p_4^*$ , with occasionally one or more small faces of the form a (100). Very few of the grains were bounded completely by crystal faces, ragged outlines replacing them in part. The diameter varied from 0.03 to 0.20 mm., the thickness from 0.01 to 0.05 mm.

Most of the crystals were perfectly transparent, but some were slightly clouded from the presence of minute inclusions. The greater number were colourless, but some were tinged with brown, others with dull blue or green. One was seen to have a green periphery with brown centre. A good uniaxial figure was obtained, and the sign of the birefringence proved to be negative.

The only other record of octahedrite in the State is at Mt. Monger (E. S. Simpson, G.S.W.A. Bull. 90, p. 23).

\*C. (001), p. (111).